AUDIBLE NOISE SOUND LEVEL

NUMBER NINE WIND FARM 345 kV GENERATOR LEAD LINE

REVISED February 19, 2016

Prepared for:

SGC ENGINEERING, LLC

Prepared by:



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INTRODUCTION

Commonwealth Associates, Inc. was contracted by SGC Engineering to perform audible noise calculations for two sections of a 345 kV generator lead line interconnecting the new Number Nine Wind Farm (NNWF) located in Aroostook County in northern Maine. The two generator lead lines from south to north are comprised of: (1) the Bridal Path Generator Lead Line (Bridal Path) and (2) the Northern Generator Lead Line (Northern Section). The NNWF Bridal Path Generator Lead Line must be located under a Transmission Corridor Rights Agreement ("TCRA" that is filed under Section 2 of the NNWF MDEP Application) within the eastern portion of the historical 225 ft Bridal Path Right-of-Way (ROW). Specifically, the NNWF Line must be located 75 feet west of the easterly boundary of the Bridal Path ROW; this prescribed portion of the Bridal Path ROW is depicted in Exhibit 1-A and is sometimes referred to in this report as "Prescribed Portion of the Bridal Path ROW" or the "150 foot ROW".

Section 1 (Bridal Path) is 25.4 miles long within the prescribed Bridal Path ROW and will use bundled 3 x 795 kcmil ACSR Drake conductors to reduce audible noise levels. Further, in every instance where protected locations abut the ROW and there is a dwelling within 500 feet from the Edge-of-Right-of-Way (EROW), the minimum ground clearance of the conductors has been increased to 37 feet for those portions of Section 1. These portions of Section 1 (Bridal Path) are collectively referred to as the 1A Segments. The remaining portions of Section 1 are collectively referred to as the 1B Segments.

Section 2 (Northern Section) is 26.1 miles long within a 170 foot ROW. To reduce audible noise levels at protected locations that abut the ROW and have a dwelling within 500 feet from the Edge-of-Right-of-Way (EROW), the southernmost 7.8 miles of Section 2, referred to as Section 2a, will continue to use bundled 3 x 795 kcmil ACSR Drake. The remaining 18.3 miles, referred to as Section 2b, where there are no dwellings within 500 feet of a 580 foot lateral setback from the EROW, will use bundled 2 x 795 kcmil Drake conductors.

All sections include two shield wires. The H-frame generator lead line (see Exhibit 1) is located at the center of the Section 1 and Section 2 rights-of-way. The H-frame 345 kV generator lead line will be constructed using mostly wood pole structures with a conductor separation of 20.5 feet. Minimum ground clearances have been adjusted to satisfy sound level requirements and are tabulated in the following table under *Summary of Results*.

The calculated Audible Noise profiles for "Wet Conductor" and "Fair Weather" conditions for each section are shown in Exhibit 2 as lateral profiles measured relative to the EROW of the generator lead line; per standard practice, the calculations are (1) based on the minimum ground clearance (and the clearance is based on the rated capacity of the line) and (2) made at the average conductor height under operating conditions which result in maximum conductor sag, the point at which the highest sound levels occur. Calculations for each portion of the generator lead lines were made assuming the maximum altitude of the line for that portion.

SUMMARY OF RESULTS

This table describes the Wet Conductor (Wet) and Fair Weather (FW) audible noise for the 1A Segments, 1B Segments, Section 2a and Section 2b, including the audible noise at the EROW and 500 feet beyond the EROW. Section 2b also extends the audible noise profile beyond the 500 feet from the EROW to show where the audible noise falls below 37 dBA (i.e. 36.9 dBA at 580 feet) for the 2 x 795 Drake conductors.

	Min.	EROW		EROW +500'		EROW +580'			
			Ground Clearance	Wet (dBA)	FW (dBA)	Wet (dBA)	FW (dBA)	Wet (dBA)	FW (dBA)
	Bridal	3x795 -							
1A Segments	Path	150' ROW	37'	36.8	24.2	24.5	11.9	-	-
	Bridal	3x795 –							
1B Segments	Path	150' ROW	32'	37.0	24.4	24.5	12.0	-	-
	Northern	3x795 –							
Section 2a	Section	170' ROW	32'	36.4	23.6	24.2	11.5	-	-
	Northern	2x795 -							
Section 2b	Section	170' ROW	30'	50.5	42.6	38.3	30.5	36.9	29.0

CALCULATIONS

The calculations for audible noise profiles were made using the TRALIN module of the CDEGS program utilizing the EPRI/GE method. The audible noise calculations were performed for both "Wet Conductor" and "Fair Weather" weather conditions.

Section 1, 1A Segments – (Bridal Path) (see SGC maps attached under Exhibit 3) includes spans adjacent to protected locations with a dwelling within 500 feet from EROW and is based on:

2

150 ft ROW
20.5 ft conductor separation
37 ft minimum ground clearance*
3 x 795 ACSR Drake
Two shield wires
At a maximum altitude of 250 meters
105% nominal voltage on phase conductors

Section 1, 1B Segments – (Bridal Path) (see SGC Map attached under Exhibit 3) includes spans where there are no dwellings within 500 feet of the EROW and is based on:

150 ft ROW
20.5 ft conductor separation
32 ft minimum ground clearance*
3 x 795 ACSR Drake
Two shield wires
At a maximum altitude of 250 meters
105% nominal voltage on phase conductors

Section 2a – continuous portion of Section 2 (Northern Section) that includes some adjacent protected locations, (see SGC maps under Exhibit 4) and is based on:

170 ft ROW
20.5 ft conductor separation
32 ft minimum ground clearance*
3 x 795 ACSR Drake
Two shield wires
At a maximum altitude of 210 meters
105% nominal voltage on phase conductors

Section 2b – continuous portion of Section 2 (Northern Section) where there are no dwellings within 500 feet of a 580 foot lateral setback from the EROW (see SGC maps under Exhibit 4) and is based on:

170 ft ROW
20.5 ft conductor separation
30 ft minimum ground clearance*
2 x 795 ACSR Drake
Two shield wires
At a maximum altitude of 400 meters
105% nominal voltage on phase conductors

Coordinates used for calculations were based on the tangent structure described in Exhibit 1-B and are shown below. The first number in each set is the horizontal distance in feet from the center line of the structure/right-of-way. The second number is the minimum height above level ground that the generator lead line is predicted to reach.

Phase A	Phase B	Phase C	Shield Wire 1	Shield Wire 2
1A Segments				
(-20.5', 37')	(0', 37')	(20.5', 37')	(-10.5', 64.75')	(10.5', 64.75')
1B Segments, Section	on 2a			
(-20.5', 32')	(0', 32')	(20.5', 32')	(-10.5', 59.75')	(10.5', 59.75')
Section 2b				
(-20.5', 30')	(0', 30')	(20.5', 30')	(-10.5', 57.75')	(10.5', 57.75')

^{*} Ground clearance is for the center of each phase bundle per the proposed design.

AUDIBLE NOISE RESULTS

Corona is a common characteristic of EHV lines like the Number Nine Wind Farm 345 kV generator lead lines. The corona discharges from the surfaces of the 345 kV conductors cause audible noise. As stated previously, these calculations were made for both wet conductor and fair weather conditions. Wet conductor conditions, which includes conditions following rainfall and conditions where heavy humidity causes condensation on the warmed generator lead line conductors, will cause additional corona activity due to the water drops hanging from the bottom side of the conductors and result in higher audible noise levels. During heavy rain, audible noise levels are modestly higher than under wet conductor conditions, but the noise from the heavy rainfall masks the noise from the generator lead line. The exclusion of noise during heavy rain is supported both by standard industry practice and as described in (I) (8) (e) (8) which states: ... extraneous ambient noise sources that affect the ability to demonstrate compliance shall be excluded from all compliance report data.

For measurements at the EROW and beyond the standard industry practice is to use the average conductor height for calculating the audible noise (the average conductor height is calculated by adding one-third of the conductor sag to the minimum ground clearance, thus 30' + 8' = 38' average; 32' + 8' = 40' average; and 37' + 8' = 45' average).

Commonwealth evaluated sound levels expected from the generator lead lines (both the Bridal Path and the North Generator Lead Lines) based upon the sound limits defined in Chapter 375 Section 10 (I) of the Maine Department of Environmental Protection (DEP) Rules.

Section 10 (I) applies to routine operation of a grid scale wind energy development measured in accordance with Subsection (I) (8) and requires a "nighttime limit" (between 7:00 p.m. and 7:00 a.m.) of 42 dBA within 500 feet of a dwelling at any protected location. Subsection (I) (3) requires the application of an additional 5 dBA *Tonal Sound* penalty to be applied if the ten minute equivalent average sound of a grid scale wind energy development at a given one-third octave band exceeds the two contiguous/adjacent one-third octave bands by:

- 1. 5 dBA for center frequencies of 500 to 10,000 Hz
- 2. 8 dBA for center frequencies of 160 to 400 Hz
- 3. 15 dBA for center frequencies of 25 to 125 Hz

For the 345 kV generator lead lines the typical noise spectrum at 60, 120 and 240 Hz demonstrate audible noise peaks with the dominant peak at 120 Hz. It has been estimated that for 345 kV lines the dominant peak at 120 Hz (125 Hz one-third octave) has the potential to exhibit more than a 15 dBA drop in the adjacent one-third octave bands. Therefore, continuously occurring "wet conditions", with a tonal sound supporting application of the 5 dBA Tonal Penalty, has been assumed for purposes of this Revised Report for the Generator Lead Line.

The net effect of applying both Subsections (I) (3) and (I) (8) to the generator lead lines is that a 5 dBA Tonal Penalty is assumed and therefore subtracted from the 42 dBA nighttime sound level limit (between 7:00 p.m. and 7:00 a.m.) to derive a "target sound level" of 37 dBA for purposes of this Revised Report.

REVISED DESIGN AND RELATED SOUND LEVEL CALCULATIONS

Adjustments were made to the original transmission line design to meet the above sound level target. For all of Section 1 (Bridal Path) and for Section 2a, a third 795 kcmil ACSR Drake conductor was added to form a triple conductor bundle (3x795) for each of the three phases of the 345 kV generator lead line. The effect of adding the third conductor is a reduction in the sound level at the EROW. Section 1 (Bridal Path) assumes a narrower 150 foot ROW, compared to the 170 foot ROW used for Section 2 (Northern Section). In addition, 1A Segments were identified along the Section 1 (Bridal Path) for spans where adjacent protected locations that contain a dwelling within 500 feet of the EROW were identified.

For 1A Segments the ground clearance of the conductors was raised by an additional five feet to provide a 37 foot minimum ground clearance in order to meet the 37 dBA requirement at the EROW. Audible noise from both the 1A Segments and Section 2a are under the 42 dBA nighttime limit with the 5 dBA Tonal Penalty included (37 dBA target sound level). The 1B Segments (Bridal Path) were identified where no regulated protected locations are found with a dwelling within 500 feet of the EROW.

In addition, Section 2a was extended by approximately 1.3 miles, thereby assuring that there are no dwellings within 500 feet of a 580 foot lateral setback from the EROW along Section 2b.

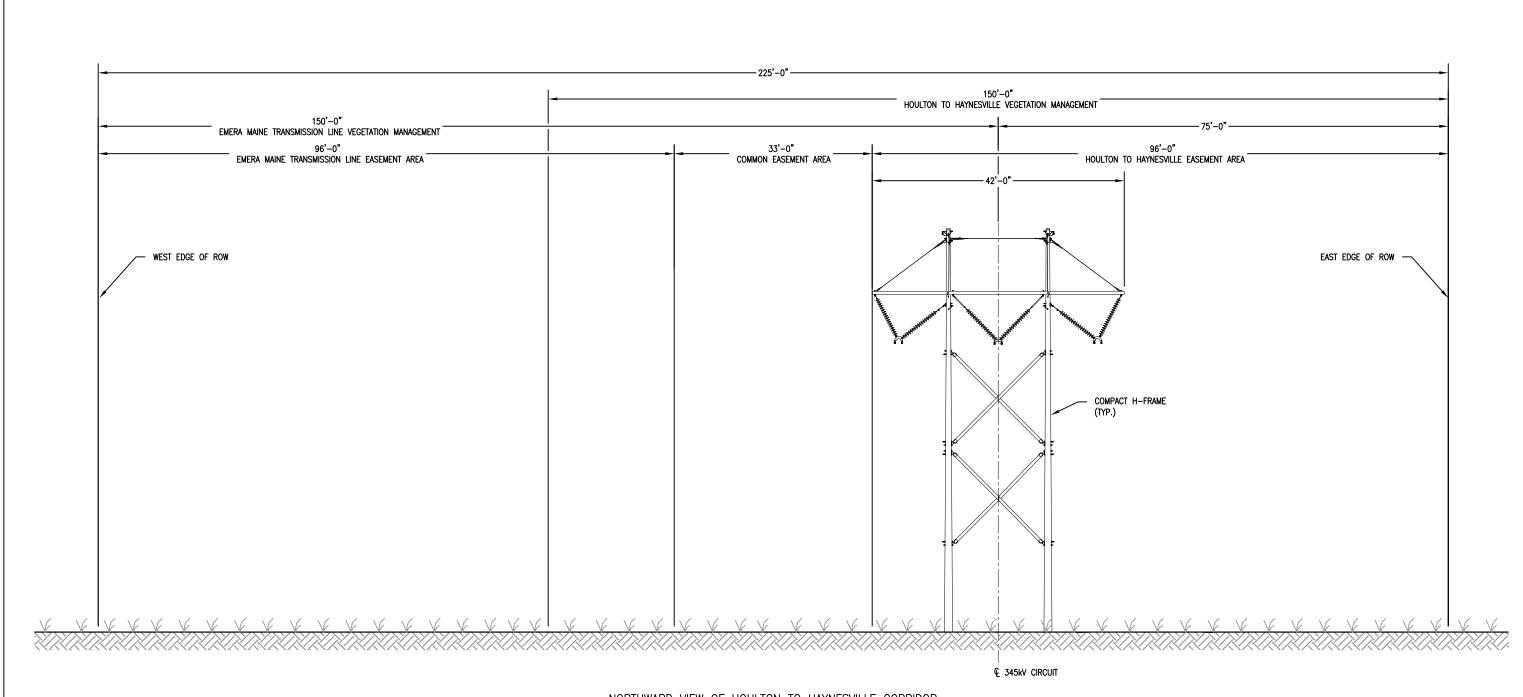
Exhibit 2 provides audible noise profiles extending from the EROW and out to 500 feet from the EROW. For Section 2b the sound level profile is extended to show where the audible noise sound level drops below 37 dBA target level for the 2 x 795 Drake conductors (36.9 dBA @ 580 feet).

Exhibit	Section	Conductors	Atmospheric Conditions
Exhibit 2.1a.1	1A Segments	3x795	Wet Conductor
Exhibit 2.1a.2		3x795	Fair Weather
Exhibit 2.1b.1	1B Segments	3x795	Wet Conductor
Exhibit 2.1b.2		3x795	Fair Weather
Exhibit 2.2a.1	Section 2a	3x795	Wet Conductor
Exhibit 2.2a.2		3x795	Fair Weather
Exhibit 2.2b.1	Section 2b	2x795	Wet Conductor
Exhibit 2.2b.2		2x795	Fair Weather

Aerial based maps prepared by SGC Engineering showing the ROW for the Generator Lead Lines, and any related dwelling-based or parcel- based Protected Locations along the ROW, are attached to this Revised Report as Exhibit 3 (Bridal Path) and Exhibit 4 (Northern Section). These Exhibits 3 and 4 depict the areas where design adjustments have been made for the 1A Segments along the Bridal Path and also where Section 2a has been lengthened to assure compliance for both Sections 2a and 2b of the Northern Section with the sound level limits.

EXHIBIT 1-A

TCRA Prescribed Layout of NNWF Bridal Path Generator Lead Line



NORTHWARD VIEW OF HOULTON TO HAYNESVILLE CORRIDOR

ISSUED FOR DISCUSSION

1 OF 1





					NO.	REVISION	APPD:	DATE:	"HOULT(
					Α	ISSUED FOR DISCUSSION	JHF	09/29/2014	
									PROJECT:
									CLIENT:
									Value
DATE:	SCALE:	DRAWN:	DESIGN:	APPD:					
SEPTEMBER 26, 2014	N.T.S.	SJF	DLH	JHF					

ULTON TO HAYNESVILLE CORRIDOR EASEMENT CONFIGURATIONS RIGHT-OF-WAY CROSS SECTION	SGC PROJECT NUMBE 275025
MOTIT-OF-WAT CROSS SECTION	<u>DRAWING NUMBER</u> 275-13-1002
AROOSTOOK COUNTY, MAINE	REVISION
EMERA MAINE TELCOM AVE BANGOR MAINE 04401	SHEET NUMBER

TELCOM AVE, BANGOR, MAINE 04401

EXHIBIT 1-B

345 kV Generator Lead Line EAR-3 (Compact Tangent) Drawing

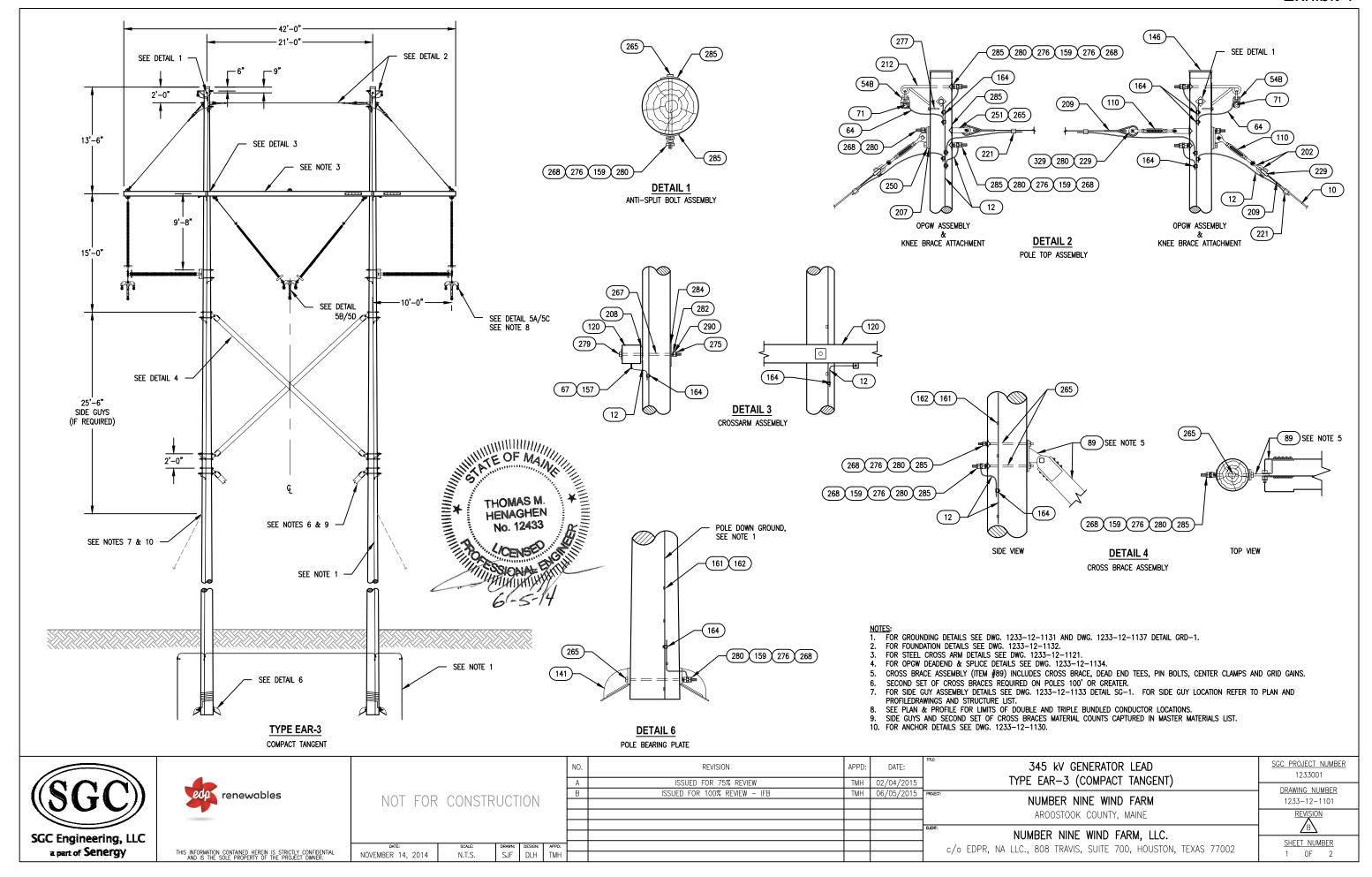


EXHIBIT 2 Audible Noise Profiles

Exhibit 2.1a.1
345 kV Generator Lead Line in Maine - 25.4 Miles Section 1 (Bridal Path)*
1A Segments - Bundled 3 x 795 Drake, 37' GC, 150' ROW
Calculated for Wet Conductor Conditions

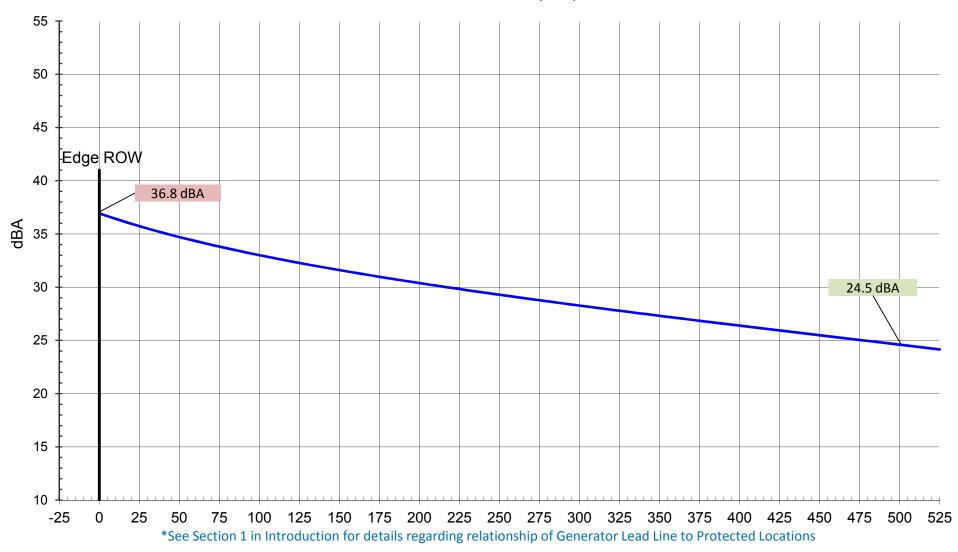


Exhibit 2.1a.2
345 kV Generator Lead Line in Maine - 25.4 Miles Section 1 (Bridal Path)*
1A Segments - Bundled 3 x 795 Drake, 37' GC, 150' ROW
Calculated for Fair Weather Conditions

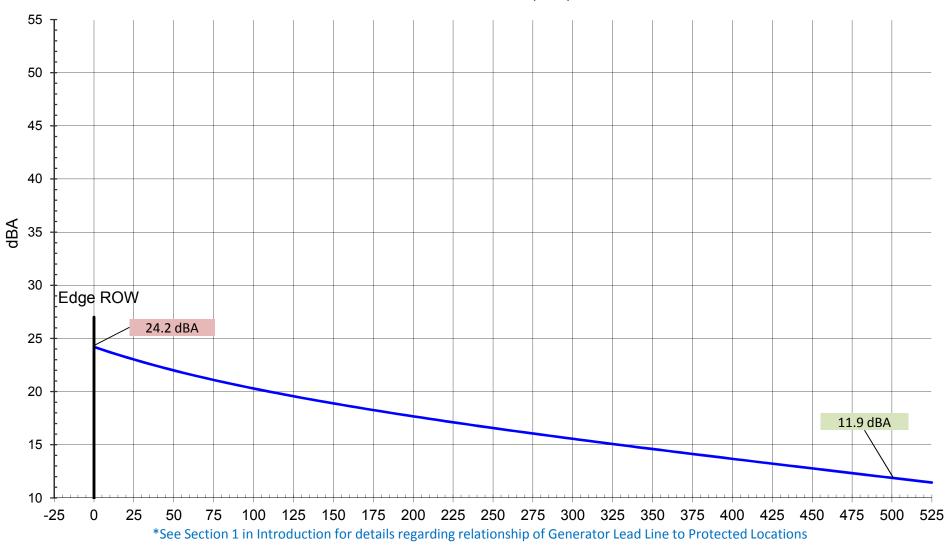


Exhibit 2.1b.1

345 kV Generator Lead Line in Maine - 25.4 Miles Section 1 (Bridal Path)*

1B Segments - Bundled 3 x 795 Drake, 32' GC, 150' ROW

Calculated for Wet Conductor Conditions

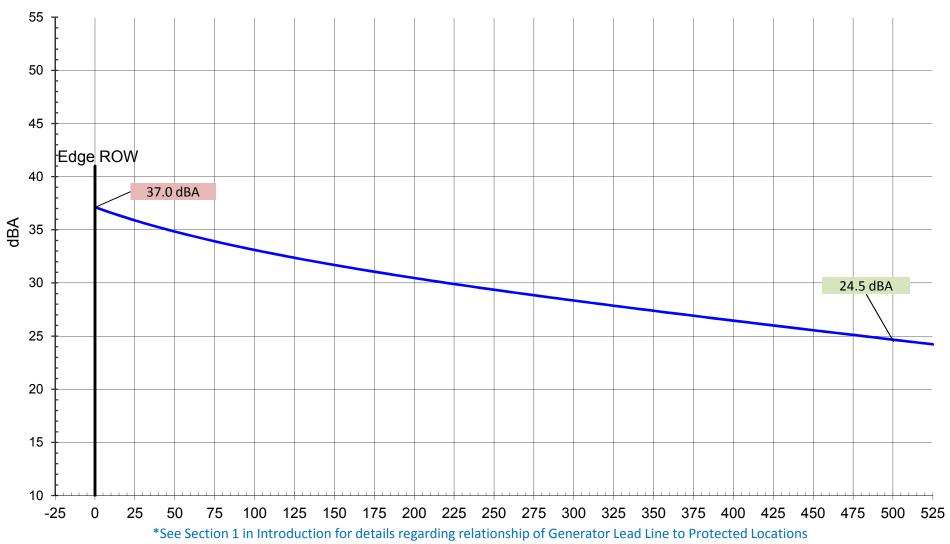


Exhibit 2.1b.2
345 kV Generator Lead Line in Maine - 25.4 Miles Section 1 (Bridal Path)*
1B Segments - Bundled 3 x 795 Drake, 32' GC, 150' ROW
Calculated for Fair Weather Conditions

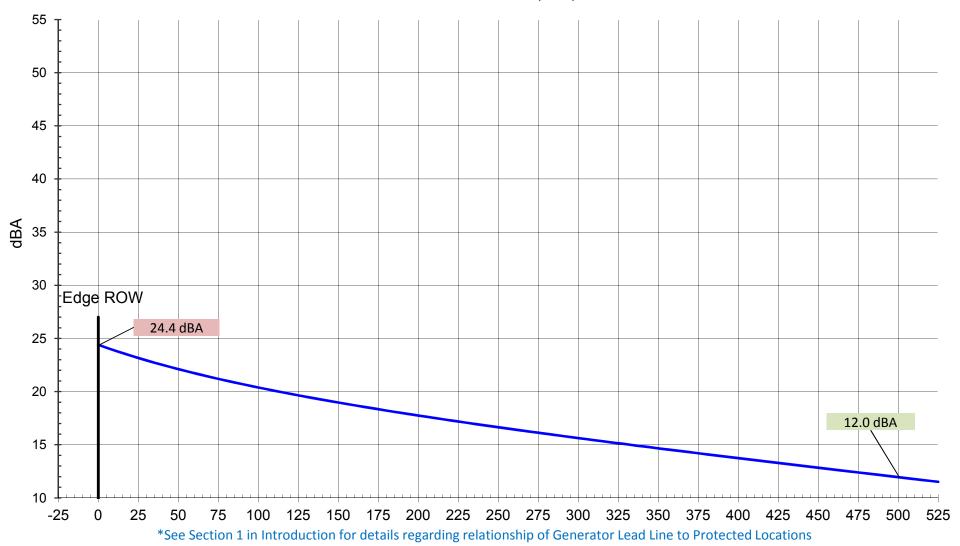


Exhibit 2.2a.1
345 kV Generator Lead Line in Maine - Section 2 (Northern Section)*
Section 2a 7.8 Miles - Bundled 3 x 795 Drake, 32' GC, 170' ROW
Calculated for Wet Conductor Conditions

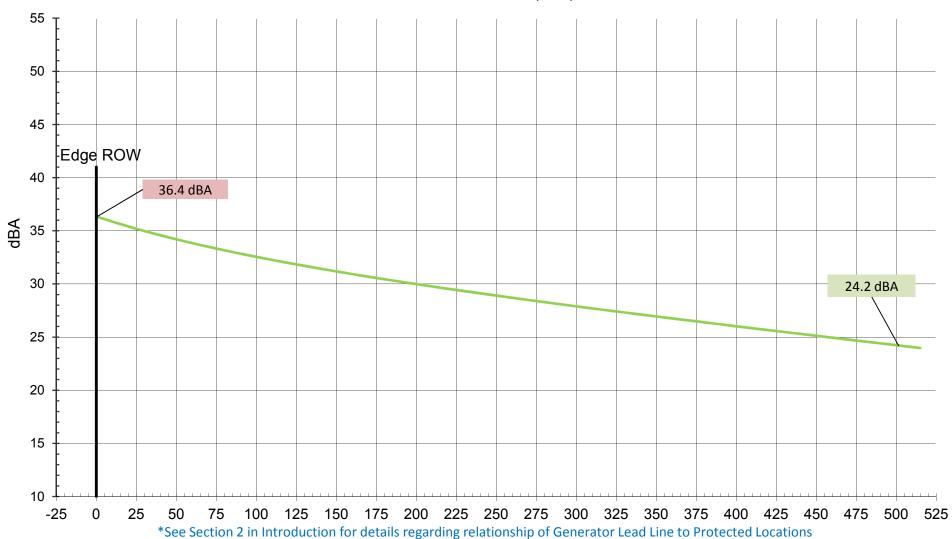


Exhibit 2.2a.2
345 kV Generator Lead Line in Maine - Section 2 (Northern Section)*
Section 2a 7.8 Miles - Bundled 3 x 795 Drake, 32' GC, 170' ROW
Calculated for Fair Weather Conditions

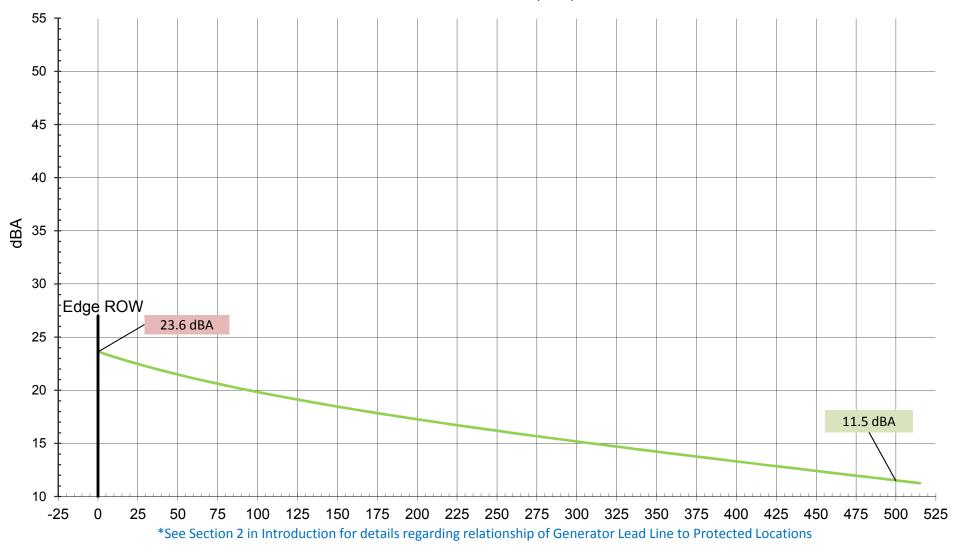


Exhibit 2.2b.1
345 kV Generator Lead Line in Maine - Section 2 (Northern Section)*
Section 2b 18.3 Miles - Bundled 2 x 795 Drake, 30' GC 170' ROW
Calculated for Wet Conductor Conditions

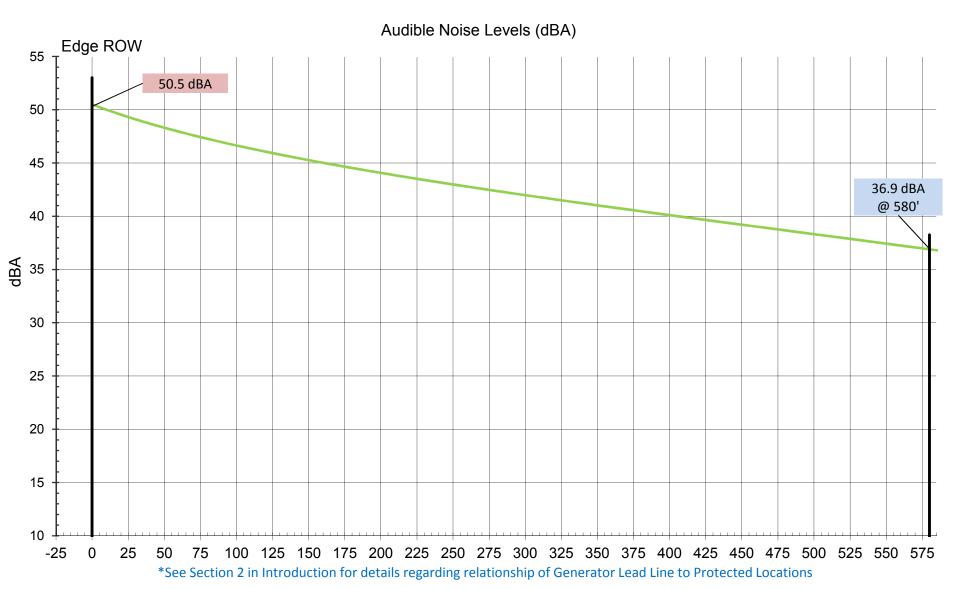
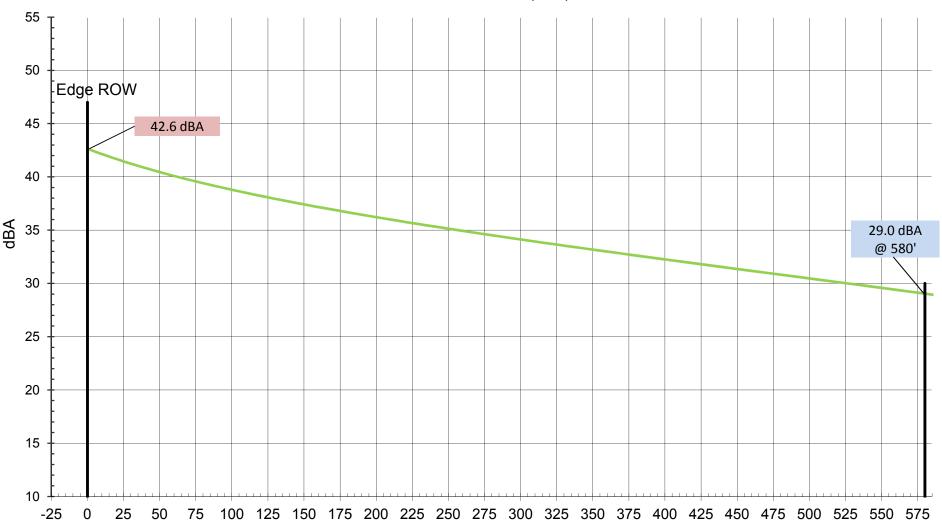


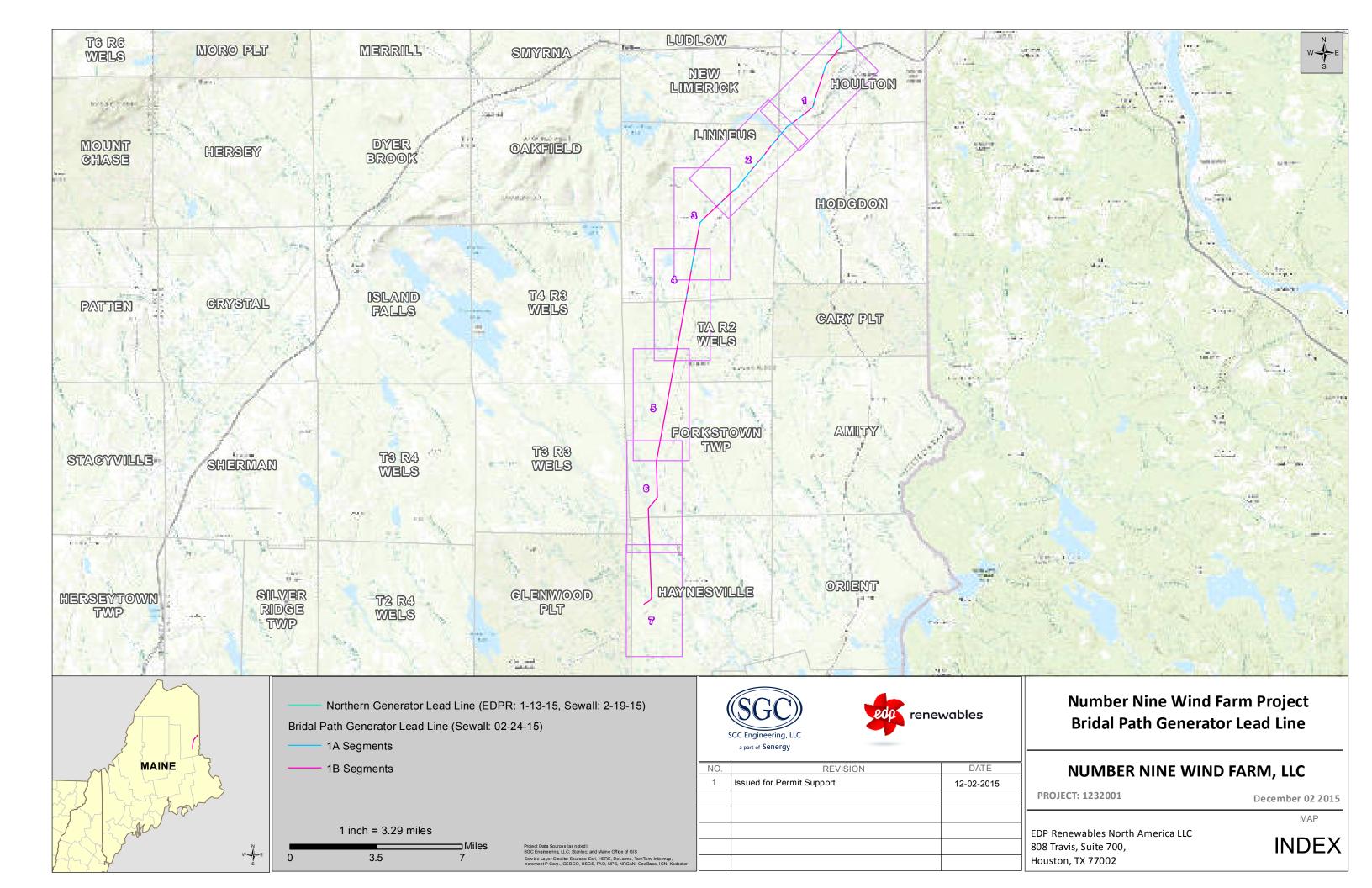
Exhibit 2.2b.2
345 kV Generator Lead Line in Maine - Section 2 (Northern Section)*
Section 2b 18.3 Miles - Bundled 2 x 795 Drake, 30' GC, 170' ROW
Calculated for Fair Weather Conditions

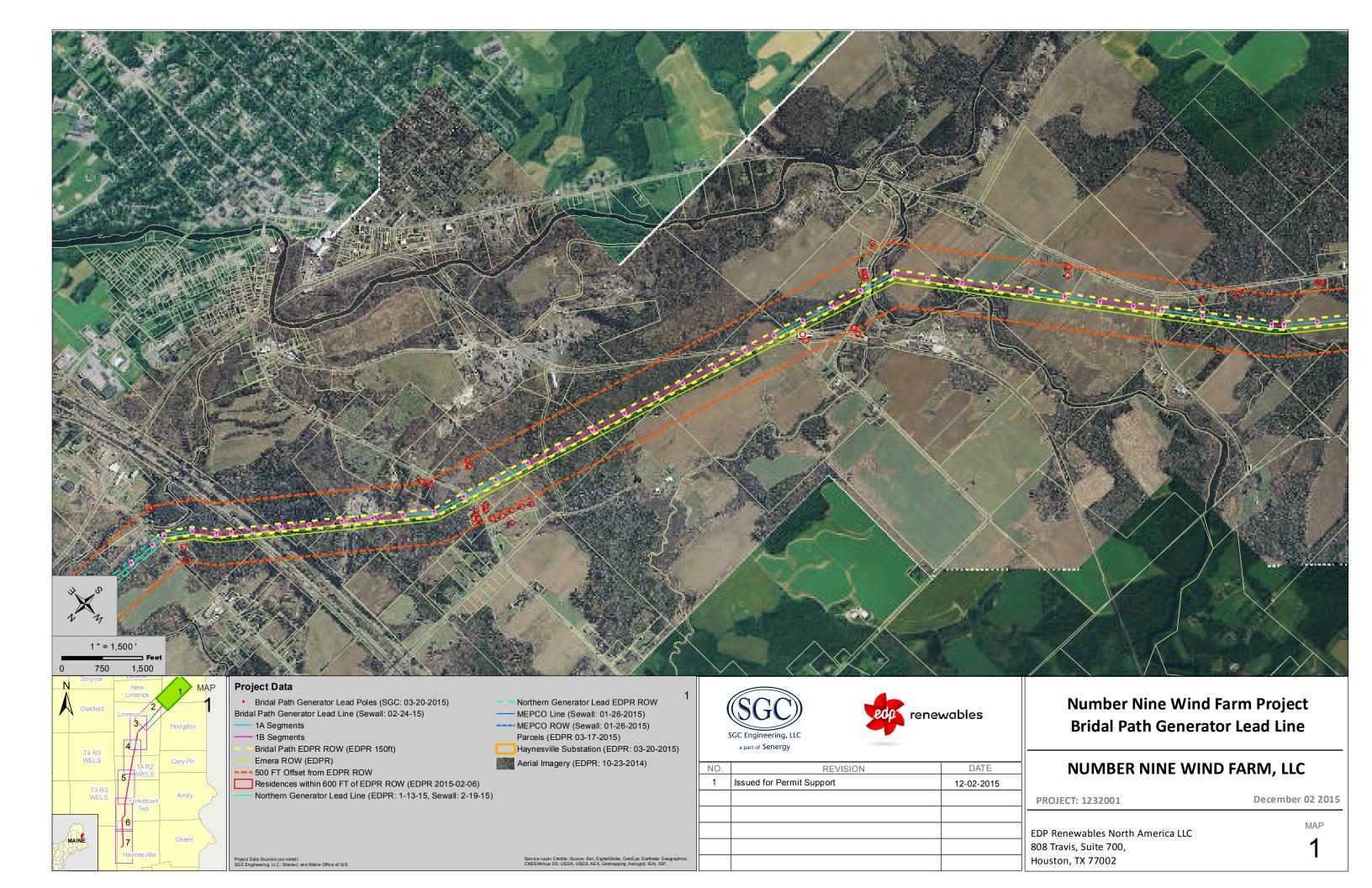


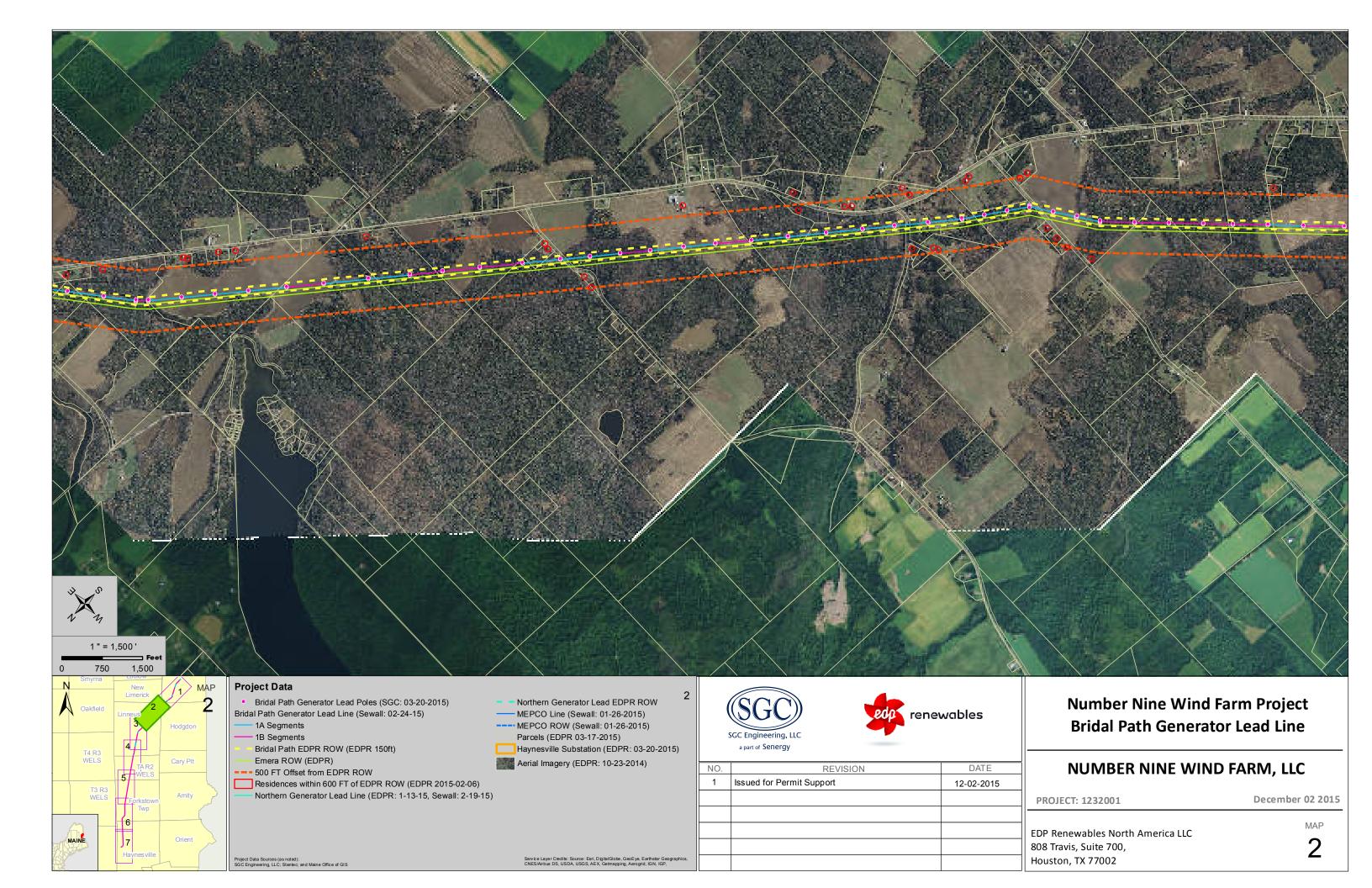
*See Section 2 in Introduction for details regarding relationship of Generator Lead Line to Protected Locations

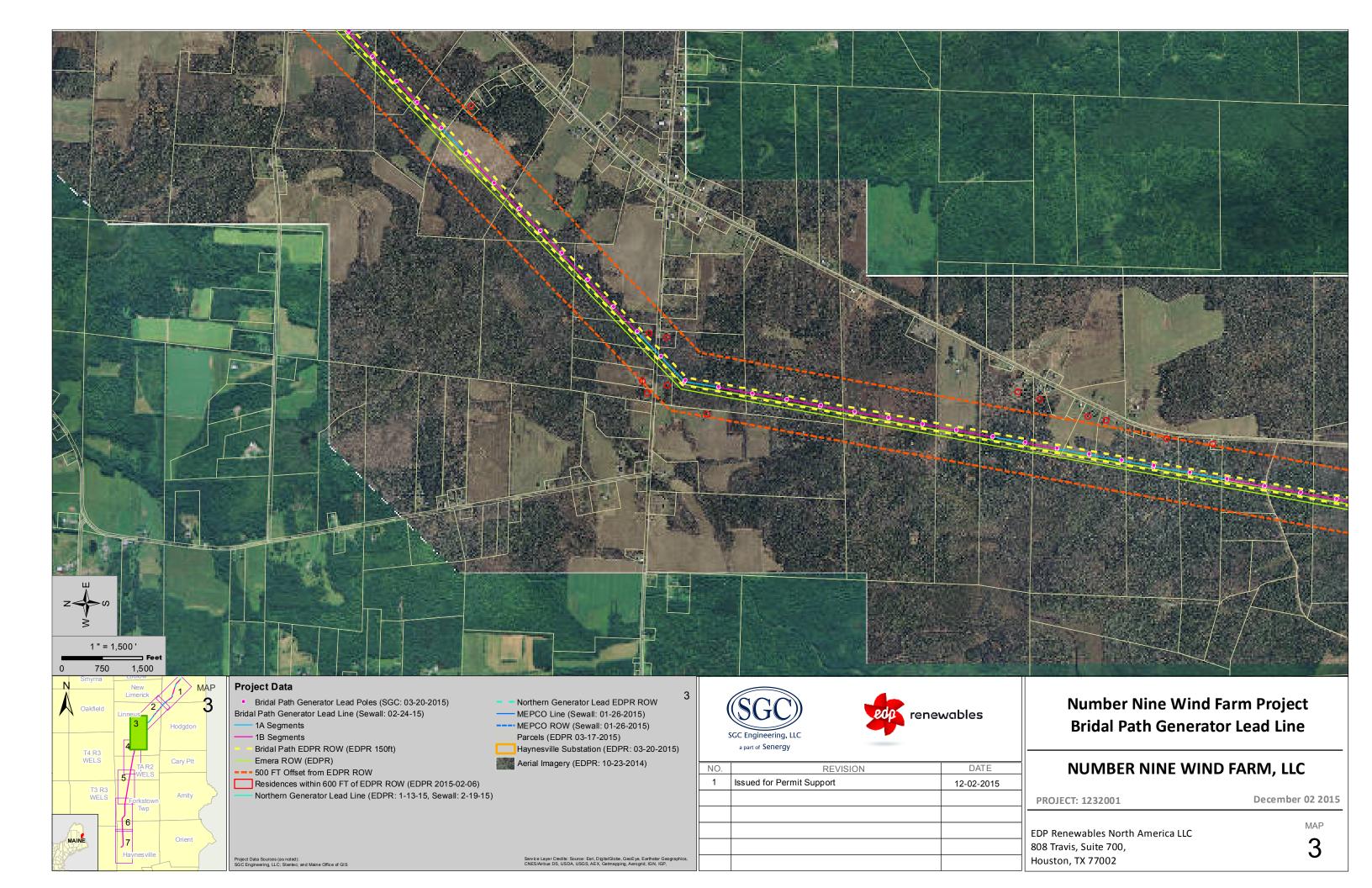
EXHIBIT 3

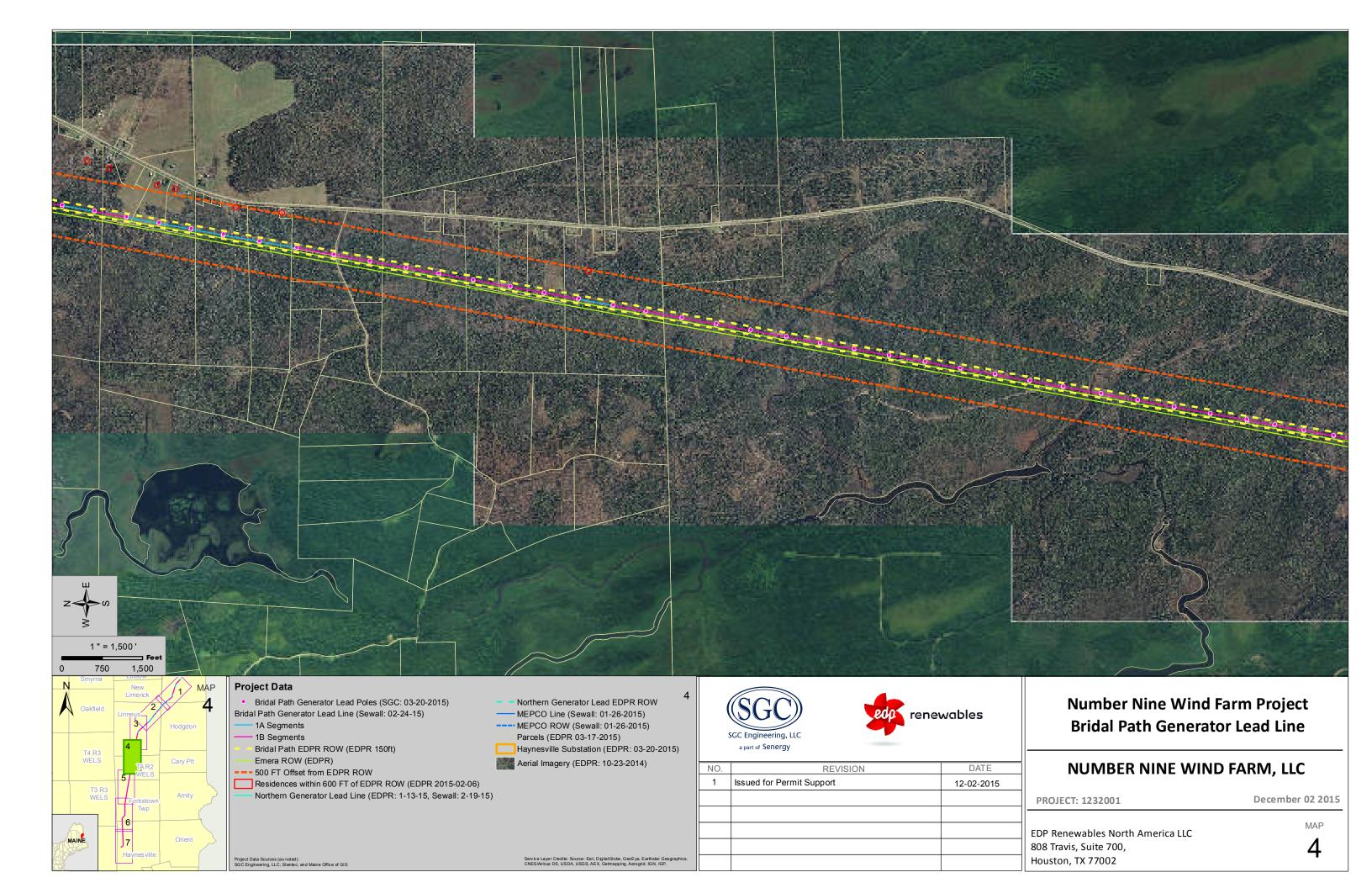
Section 1 (Bridal Path) SGC Maps

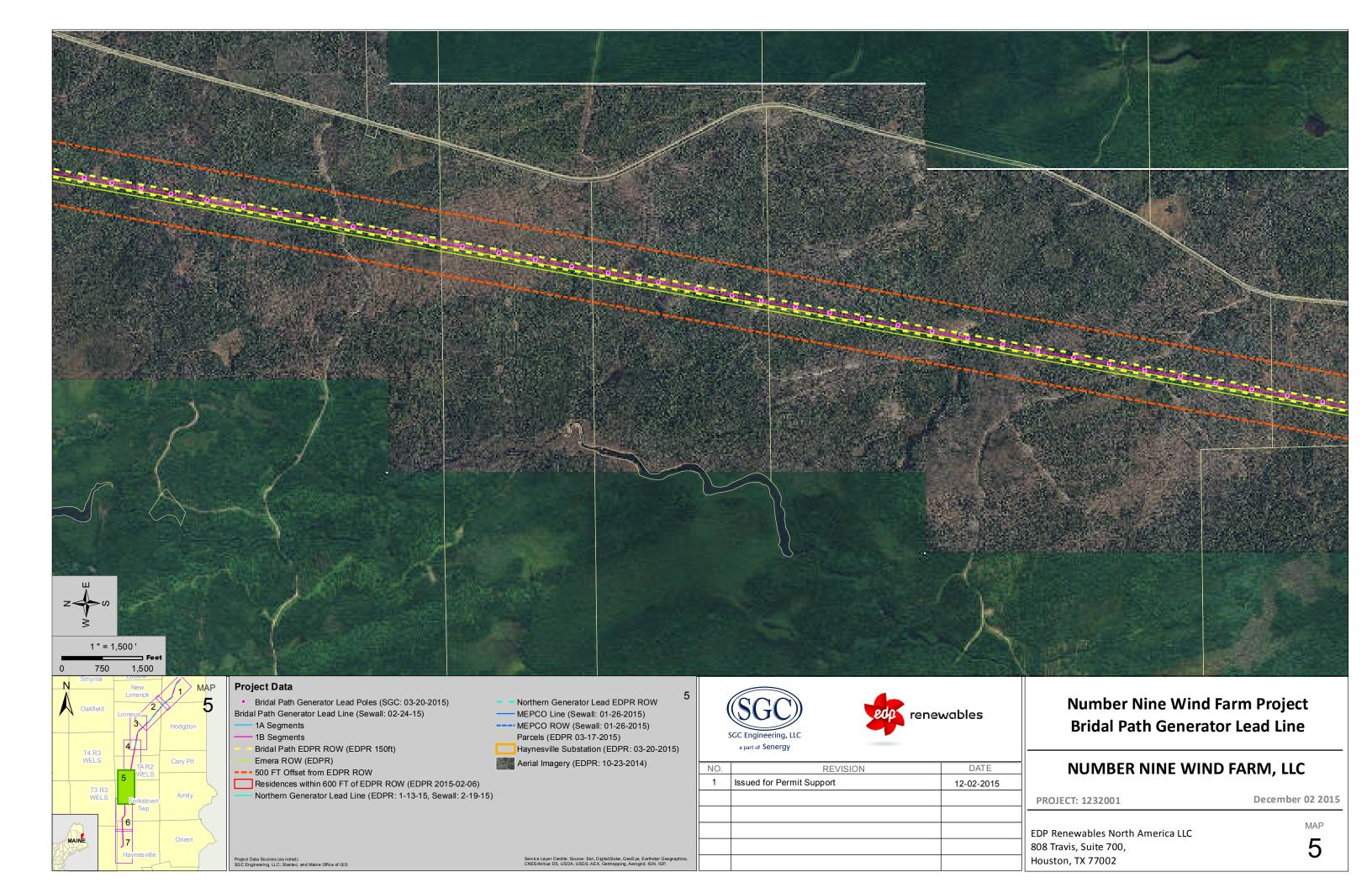


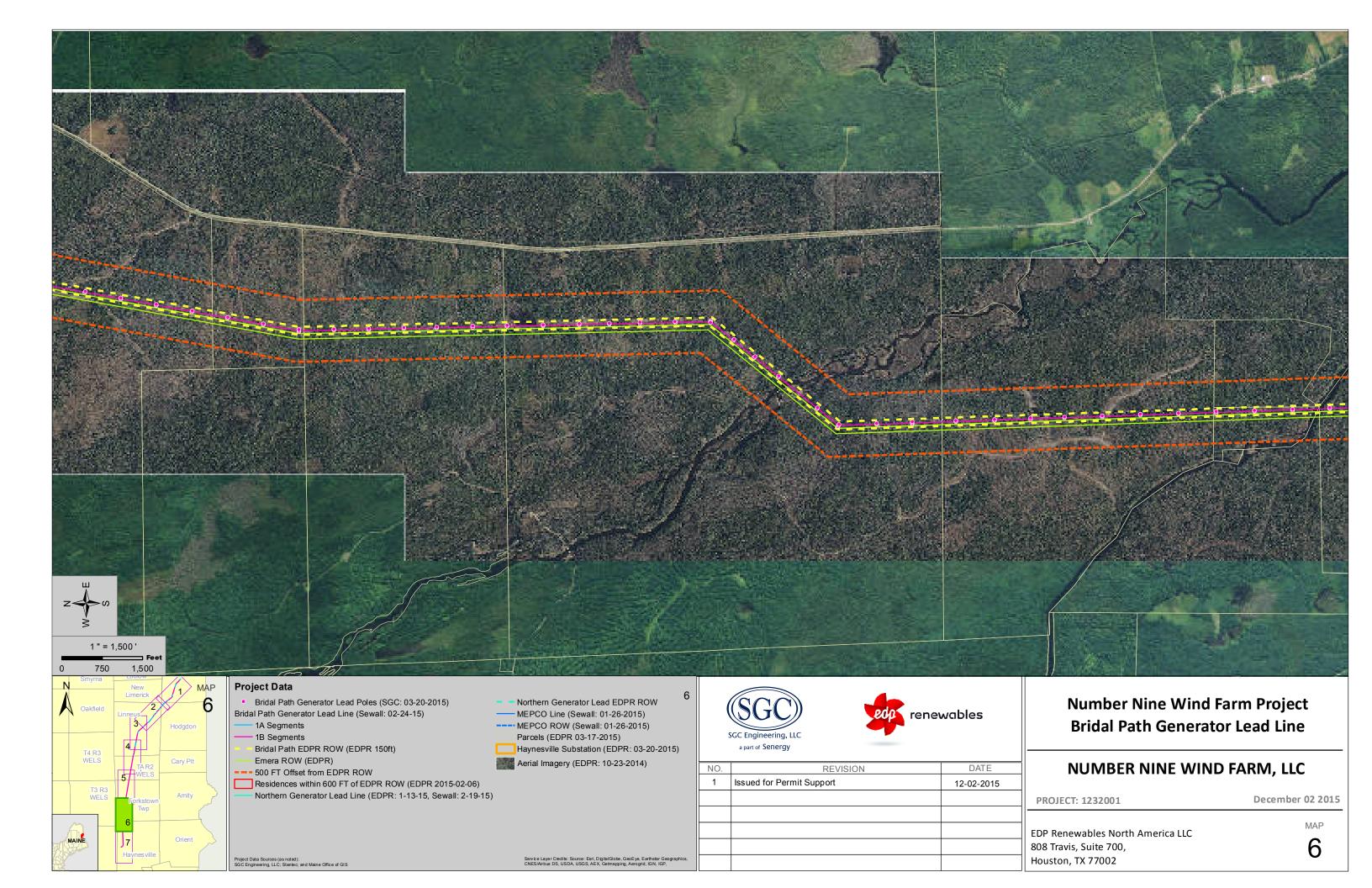












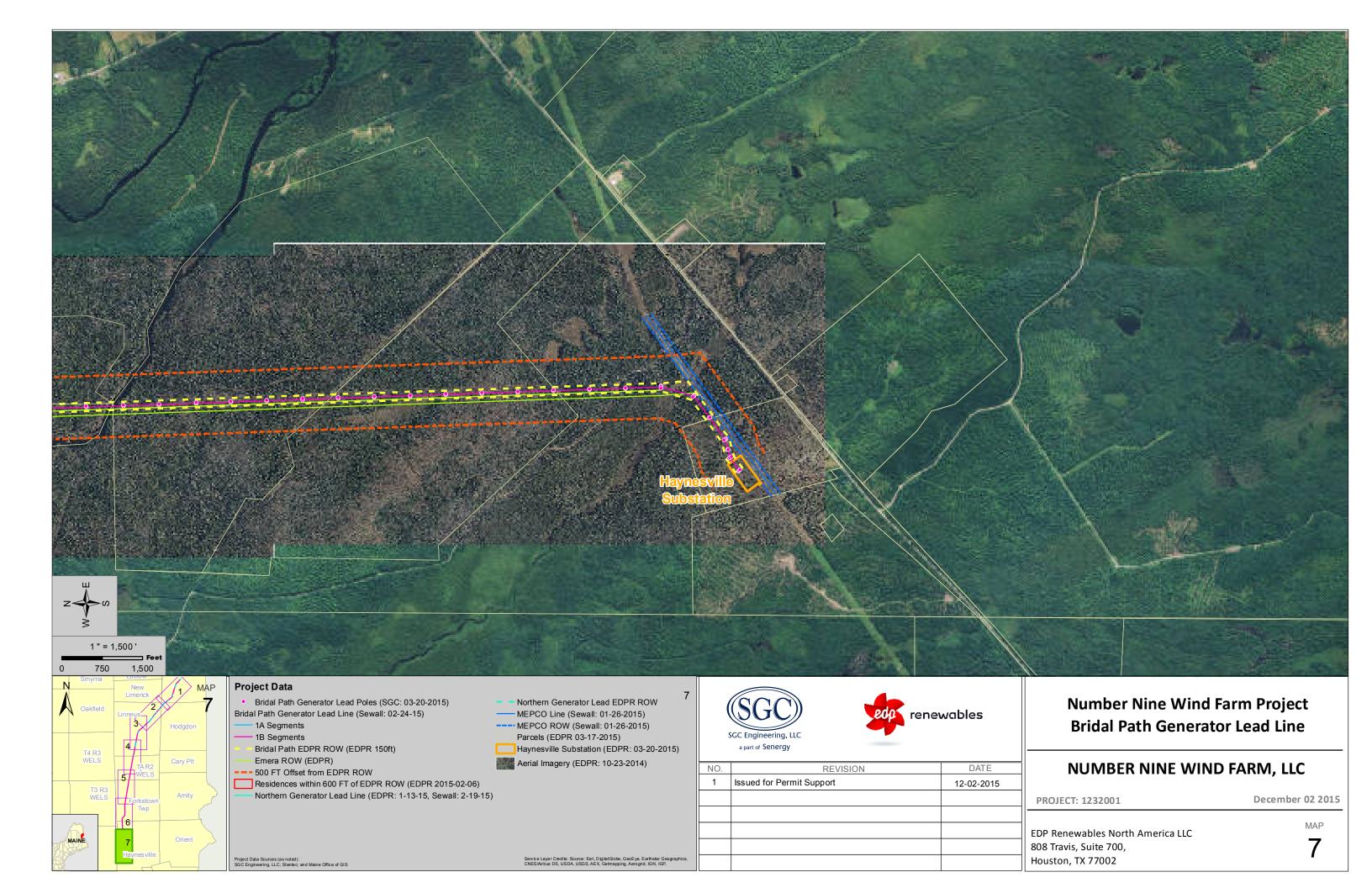


EXHIBIT 4

Section 2 (Northern Section)
SGC Maps

